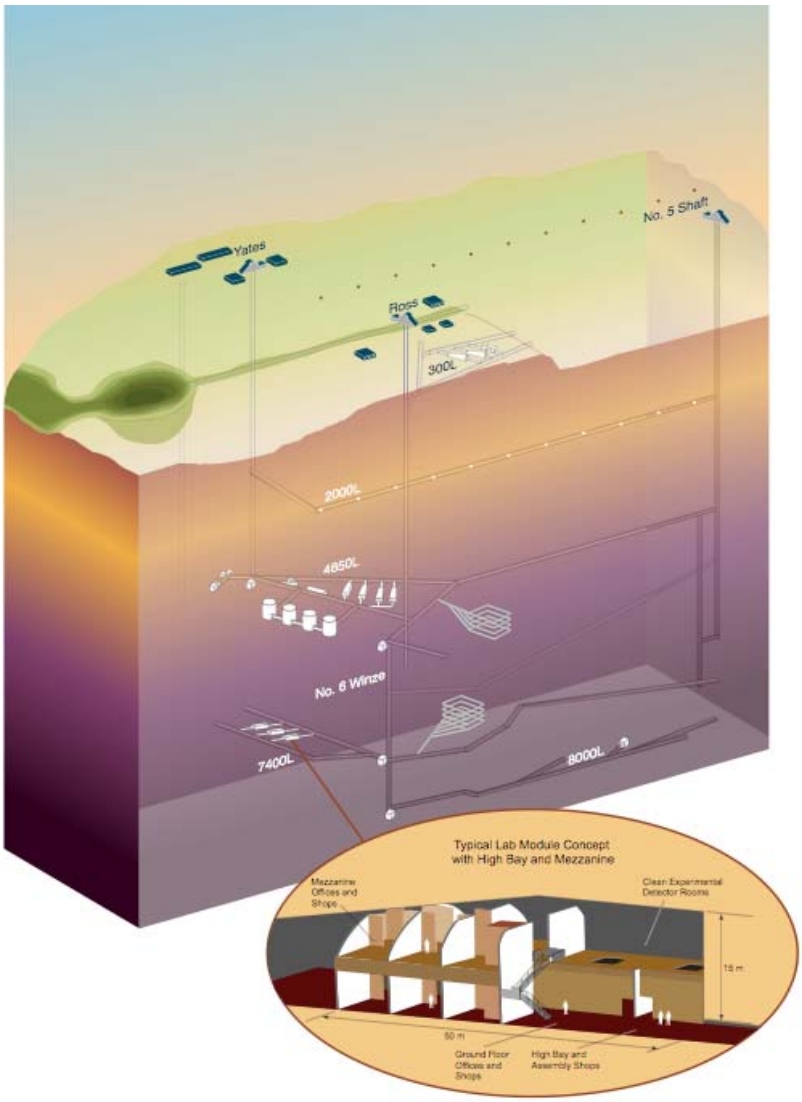
The Deep Underground Science and Engineering Laboratory at Homestake:

Conceptual Design Report



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[1] Some edits, mainly for reference updates, are incorporated in this version, released after site selection announcement: http://www.nsf.gov/news/news_summ.jsp?cntn_id=109694&org=NSF&from=news

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Abstract: We propose the former Homestake mine as the site for the National Science Foundation's Deep Underground Science and Engineering Laboratory (DUSEL). Homestake offers many advantages over other possible sites for creating a dedicated, multidisciplinary laboratory. These advantages include well-characterized, varied, and interesting geology; expeditious access to great depths; significantly reduced technical risk; dedication to research without disruption from mining or other commercial uses; capacity to host a comprehensive, international, multidisciplinary suite of experiments; and ability to expand in capacity and depth as the science and education programs evolve in the coming decades.

Significant early work is already in progress. To acquire Homestake for scientific purposes, the State of South Dakota established the South Dakota Science and Technology Authority (the Authority) in 2004. Since 12 May 2006 the Authority has owned and occupied the property. In preparation for DUSEL, the Authority has also: 1) attended to indemnification and insurance requirements; 2) begun converting the site into a dedicated science and education facility, one without competition or interference from mining interests; 3) established a well-understood plan for rehabilitating the facility, re-establishing access to deep levels and dealing with the inflow accumulation of water; 4) established a management organization with critical environmental, safety and health functions as well as plans for transitioning into DUSEL; and 5) secured funds sufficient for five years of basic, safe operation of the infrastructure.

That second point—conversion into a laboratory—is an especially important advantage. South Dakota has committed $46M in Authority controlled funds to create the Homestake Interim Laboratory, including surface infrastructure and underground space at the 2000 and 4850 Levels (measured in feet below ground). The Homestake Interim Laboratory is the starting point for DUSEL, which will expand these facilities and develop deep modules at the 7400 and 8000 Levels and ~11 (of 60) existing levels in the facility. Starting on 2 January 2007 the Authority commenced work to rehabilitate the shafts, refurbish the pumps, and preserve the 4850 Level. The three-phased plan will first restore the surface facilities including recommissioning the hoists and associated equipment. Phase two, scheduled to begin 15 April 2007, focuses on creating safe access down the Yates and Ross shafts. Phase three will operate the pumps from 15 September 2007 through 15 June 2008 and preserve the 4850 Level infrastructure.

In addition to the State's contributions, a philanthropic donation agreement between T. Denny Sanford and the Authority, has been executed and will provide an additional $70M. These funds will complete the interim laboratory infrastructure, making it fully equipped and ready to host experiments; build a world-class Education and Outreach center; and provide funds for the creation of deep underground modules. In all, the Authority already controls a total of $116M to create an underground laboratory at Homestake.

The initial steps in defining Homestake's scientific programs have also begun. The Homestake Scientific Collaboration and the Authority issued a call for Letters of Interest and received some 85 responses. A Program Advisory Committee (PAC) was established to evaluate them and to advise the Authority on the science program for the Homestake Interim Laboratory. These Letters of Interest and the PAC report assist us greatly in planning DUSEL development by establishing a realistic database of experimental requirements and by establishing preliminary research and development (R&D) roadmaps for the many disciplines interested in using DUSEL.

The scientific program of the Interim Laboratory is called the Early Implementation Program. It includes not only the R&D phases for many of DUSEL's Initial Suite of Experiments, but also several experiments that will be ready for deployment before the DUSEL Major Research

Equipment and Facilities Construction (MREFC) proposal is prepared. Following PAC guidance, several of the Letters of Interest are being developed into Memoranda of Understanding in preparation for the installation of these experiments and efforts.

Homestake's proposed DUSEL Initial Suite of Experiments, developed from the National Science Foundation's S-1 Report and the Letters of Interest, addresses many of today's most important scientific challenges, and spans a range of disciplines. Many of them place a premium on depth, and all benefit from the dedication to science available at Homestake. They include

— Searches for dark matter and neutrinoless double beta decay

— Searches for "dark life" and the limits of life on Earth

— Long-baseline neutrino oscillation research addressing CP-violation and nucleon decay

— A vast array of earth-sciences topics, including geochemistry, hydrogeology, coupled processes, rock mechanics, underground engineering, environmental, geoneutrino, and biological investigations

— Nuclear astrophysics research

— Experiments addressing high-profile societal issues including ground water, carbon sequestration, and geothermal energy.

As we will detail at length throughout this proposal, the Homestake site and our plans for its development are an excellent match for these experiments. Homestake can host them all, and, with its combination of depth and freedom from interference by mining and other activities, can do so under something approaching ideal circumstances. We also have plans to create a world-class education and public outreach center, providing unequalled opportunities from the start of the project for fully integrating those goals with our multidisciplinary science program.

Homestake is not only a scientifically near-ideal site for DUSEL, but also a cost-effective site entailing low risk of financial, technical, or procedural issues. It is well-characterized; most of the legal and permitting issues have been dealt with; and a significant portion of the infrastructure, facility upgrades, and initial access to deep underground are financed by the Authority. No new shafts, tunnels, or drifts will be needed, even to obtain access at great depths. All this allows a large fraction of future funding to be devoted to the experimental programs.

The Authority's plans include upgrades such as an automated, on-demand personnel lift, an enhanced freight lift, and a supply of radon-reduced air. Installation of many of the infrastructure upgrades will begin as early as 2007. Consequently, Homestake provides the best "time to science," with significant results in physics, earth science, biology, engineering, and education anticipated even while DUSEL is still being developed.

We present in this document our Preliminary Project Execution Plan, including initial risk assessments and mitigation plans. Included are several environmental assessment studies, and evaluations by South Dakota's Department of Environment and Natural Resources (which is the representative of the federal Environmental Protection Agency) of Homestake's status and potential environmental risks. No project-threatening risks have been identified, and plans for dealing with the remaining lesser issues are presented. The Project Execution Plan presents design concepts, plans and schedules for laboratory development, and a preliminary cost estimate for infrastructure requirements, as well as an estimate for the DUSEL Initial Suite of Experiments.

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